ACE

SWEPAM Level-2 64-s Ion Data, HDF

97-045A-07A

The data set files are binary and in HDF format. Each file covers 27 days of data with filename format swepam_data_ion_BBBB.hdf where BBBB is the four-digit Bartel interval. Originally the data had been stored on 4-mm and 8-mm cartridge tapes, DD109205 and DC033130. The data has been completely reprocessed and fully reingested onto CD-Write Once media.

The CD-Write Once KD and KW numbers along with the corresponding time spans are as follows:

KD#	KW#	TIME SPAN
KD022368	KW000197	01/23/1998 - 01/18/2004
KD022369	KW000198	01/19/2004 - 05/05/2004

ACE

SWEPAM Level-2 1-hr SW Plasma, HDF

97-045A-07B

The data set files are binary and in HDF format. Each file covers 27 days of data with filename format swepam_data_1hr_BBBB.hdf where BBBB is the four-digit Bartel interval. Originally the data had been stored on 3480 cartridge tapes, DD109206 and DC033131. Since originally processed, updated data has been received and has been fully reingested onto CD-Write Once media.

The CD-Write Once KD and KW number along with the corresponding time span is as follows:

KD#	KW#	TIME SPAN
KD022370	KW000199	01/23/1998 - 05/05/2004

ACE

SWEPAM Level-2 1-day SW Plasma, HDF

97-045A-07C

The data set files are binary and in HDF format. Each file covers 27 days of data with filename format swepam_data_1day_BBBB.hdf where BBBB is the four-digit Bartel interval. Originally the data had been stored on 3480 cartridge tapes, DD109207 and DC033132. Since originally processed, updated data has been received and has been fully reingested onto CD-Write Once media.

The CD-Write Once KD and KW number along with the corresponding time span is as follows:

KD#	KW#	TIME SPAN
KD022371	KW000200	01/23/1998 - 05/05/2004

ACE

SWEPAM Level-2 27-day SW Plasma, HDF

97-045A-07D

The data set files are binary and in HDF format. Each file covers 27 days of data with filename format swepam_data_bartels_BBBB.hdf where BBBB is the four-digit Bartel interval. Originally the data had been stored on 3480 cartridge tapes, DD109193 and DC033127. Since originally processed, updated data has been received and has been fully reingested onto CD-Write Once media.

The CD-Write Once KD and KW number along with the corresponding time span is as follows:

KD#	KW#	TIME SPAN
KD022372	KW000201	01/23/1998 - 05/05/2004

ACE Data Processing Levels

Contents

- Data Telemetry and Level 0 Data Processing
- Level 1 Data Processing
- Level 2 Data Processing
- Ancillary Data

Data Telemetry and Level 0 Data Processing

The ACE spacecraft Command and Data Handling (C&DH) system gathers data from the instruments and formats the data into minor and major frames. One minor frame (996 bytes, including sync codes, headers and R-S check symbols) is read into the C&DH system each second and there are 16 minor frames per major frame. The C&DH system also gathers data from various analog sensors and digital telltales, from the sun sensors and star sensor, and from the command system, etc. Most of the time the spacecraft is not in touch with the ground facilities and these data are stored in an onboard Solid State Data Recorder (SSDR). Typically one contact per day is initiated by ground facilities and lasts roughly two to four hours. The SSDR is large enough to allow contacts to be spaced by more than 50 hours when necessary. The SSDR contents are read out to the ground at a rate exceeding 10 minor frames per second while current data are being simultaneously telemetered to the ground and stored in the SSDR for the next contact. The telemetry data are formatted into two virtual channels (real-time and playback) and received by the Caltech Jet Propulsion Laboratory Deep Space Network (DSN). The telemetry data are then forwarded in near real-time via the Internet to the ACE Integrated Mission Operations Center (IMOC) at the Goddard Space Flight Center (GSFC). There the data are reviewed in near real time for purposes of monitoring spacecraft and instrument status. At the end of each spacecraft contact, the DSN forwards the telemetry data to the ACE Science Center via ftp.

The data then undergo level zero processing (per NASA's standard terminology) as soon as all the data contained within the current 24 hour time frame have been received. In level zero processing, duplicate data are removed from the data stream, data are time ordered, and data quality and accounting summaries are appended. The data are formatted into a 24-hour Science Routine Data Set File (Level 0 data file). Production of Level 0 data is now the responsibility of the ACE Science Center at Caltech.

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Level 1 Data Processing

At the ACE Science Center, the data undergo level one processing, usually within a few days of receipt. In level one processing, the data are separated out by instrument and each instrument data set is formatted (using the NCSA HDF standard) in a fashion which is both consistent with the other instruments and customized to meet the special requirements of that data set and team. At this point in the processing, i.e., in level one, the data are supplemented

with ancillary data including position, attitude, and spin phase of the spacecraft; command history and comments; calibration of the spacecraft clock; and documentation of the data items. Excepting the documentation, these ancillary data are all received by the Science Center from the IMOC. The level one data are archived at the Science Center and a copy is transmitted to the National Space Science Data Center (the NSSDC) for long term archiving. Each instrument team receives a copy of all the level one data, including, of course, that from their own instrument.

In addition to formatting, level one processing includes those data processing steps which are judged to be of sufficient simplicity that they can be understood, defined, and coded before launch, and do not require iterated processing with increasing experience. Examples of such steps include decompression of compressed rate scaler data and proper time labeling of data which are buffered for a number of minor frames within the instrument before readout. A counter-example (a process which clearly does not belong in level one) is application of calibration data to convert digital pulse heights from detector signals to engineering units. Experience indicates that calibrations are often adjusted repeatedly to improve resolution based on extended iterative study of the instrument response.

In parallel with the level one processing, the level zero data is processed to yield Browse Parameters. Browse parameters are a subset of ACE measurements which allow monitoring of the solar wind and large-scale particle and magnetic field behavior. They also allow the selection of time intervals of particular interest for more intensive study. Since it is considered important to distribute first-order ACE results as soon as possible, the browse parameters are delivered to the public domain immediately, at the expense of full verification.

Click here for more detailed level 1 data documentation.

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Level 2 Data Processing

Data processing beyond Level 1 is the responsibility of the individual instrument teams. Level 2 processing includes such operations as application of calibration data and detector response maps, organization of data into appropriate energy and time bins, and application of ancillary data (for example, conversion of magnetic field vectors to useful coordinate systems using the spacecraft attitude data). The Science Center attempts to facilitate these efforts within its resources, especially when high-level processing involves multiple instrument teams. For example, much of the anisotropy/flow data for the particle instruments, in particular for the Electron, Proton, and Alpha-particle Monitor (EPAM), will be computed in terms of the direction of the magnetic field. Thus the EPAM team will need high level results from the MAG team to do high level EPAM analysis. The Science Center can facilitate data sharing and communications with its substantial data storage capabilities and its data formatting experience. Another example is the high level processing for the Cosmic Ray Isotope Spectrometer, CRIS. Four institutions are involved in this processing, each contributing expertise and experience in a different sub-assembly of this very complex instrument. Communications and iteration of the data processing are being facilitated by the Science Center for this team.

Each instrument team is required to deliver level two data back to the Science Center, which will then make the data available to the other instrument teams, the space science community (as required by NASA), and the NSSDC for long term archiving. Delivery of level two data back to the Science Center is expected to begin about three months after the spacecraft enters orbit about the L1 Lagrangian point. Thereafter, roughly a two month lag time is expected between receipt of level one data by the instrument teams and delivery of level two data back to the Science Center. However, these delivery schedules may require revision if instrument checkout and debugging take longer than expected. In addition, the level two dataset is expected to be evolutionary, in the sense that an instrument team may enhance their level two data with additional products in the future, as the sophistication of their analysis increases.

Access ACE Level 2 data.

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Ancillary Data

Ancillary data is data provided by various sources in addition to what is telemetered from the spacecraft. This includes attitude and position solutions from Flight Dynamics and onboard clock calibration data from the Flight Operations team. These data are either folded into the Level 1 data at the Science Center, and/or provided to the instrument teams in addition to the Level 1 data.

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Our Email Address: asc@srl.caltech.edu

Last Updated: Sep 24, 1998

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ACE Level 2 Data Policy Statement

- ACE data processing beyond level 1 is the responsibility of each instrument team. Level 2 processing includes the application of calibration data and detector response maps, organization of data into appropriate energy and time bins, and transformation of vector data into appropriate coordinate systems.

- The quality of ACE level 2 data is intended to be such that it is suitable for serious scientific study. However, to avoid confusion and misunderstanding, it is recommended that users consult with the appropriate ACE team members before publishing work derived from the data.

- The ACE team has worked hard to ensure that the level 2 data are free from errors, but the team cannot accept responsibility for erroneous data, or for misunderstandings about how the data may be used. This is especially true if the appropriate ACE team members are not consulted before publication. At the very least, preprints should be forwarded to the ACE team before publication.

- The appropriate ACE team members should be acknowledged in any publication derived from the ACE data. Guidelines for acknowledging your use of ACE Level 2 data

- It is requested that the ACE team be informed (eg: by email to asc@srl.caltech.edu) of any presentations and publications that use ACE data, and that preprints and reprints of such publications be sent to the ACE Science Center for inclusion in the library of ACE-related publications.

- The ASC acts as a central facility where all the level 2 data from each instrument is gathered from the instrument teams and converted to a common data format - Hierarchical Data Format (HDF).

- When possible, the ASC ensures that time-averaged level 2 data from different ACE instruments have common time boundaries. This is generally true for hourly and longer time averages, but not for shorter time averages.

- ACE level 2 data in HDF format are archived at the ASC and will also be sent to the NSSDC for long-term archiving. The data will be available to the scientific community from both the ASC and the NSSDC.

- The ASC will provide software and documentation to facilitate access to ACE level 2 data.

- The instrument teams began delivery of level 2 data to the ASC in the 4th quarter of 1998. Testing, verification of the data, and conversion to HDF format has been completed for some instruments, and is in the final stages for others. When level 2 delivery becomes routine, the ASC expects to receive the level 2 data from the instrument teams about two months after the instrument teams receive the level 1 data from the ASC.

- The ACE level 2 data are expected to be evolutionary, in the sense that an instrument team may enhance their

level 2 data with additional products in the future, as the sophistication of the data analysis improves.

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Last Updated: 5 May, 2000

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ACE Level 2 Timing Data

All ACE level 2 data records contain timing data in the same format. The timing data indicate the start of the integration period for the data record, in Universal Time (UT), and are formatted as follows:

- `year - int32 year`
- `day - int32 day of year (first day of year is day 1)`
- `hr - int32 hour of day`
- `min - int32 minute of hour`
- `sec - float32 seconds (accurate to millisec)`
- `fp_year - float64 floating point (fractional) year`
- `fp_doy - float64 floating point day of year (starting at 1.0)`
- `ACEepoch - float64 ACE epoch time in seconds since Jan 1, 1996 at 0hr UT`

The Bartels Calendar

J. Bartels defined his calendar based on observations of daily geomagnetic activity. Over long periods the geomagnetic recurrence rate is very close to 27 days. (The equatorial rotation rate of the Sun is also close to 27 days.) Rotation 1 Day 1 in this sequence was assigned arbitrarily by J. Bartels to February 8, 1832.

For reference, Bartels rotation 2270 started on November 2, 1999, at 00:00:00 UT.
Here is a list of bartels rotation start-times for the ACE mission.

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Last Updated: 11 November, 1998

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05-28-2003 Release of new version of the SWEPAM Level 2 data
for the entire mission
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Changes for this release are:

1) Included updated instrument calibrations. This is done to account for changing CEM gains, and is based on weekly on-board calibrations done by sweeping the CEM voltages. Gain changes have been observed in 2 of the ion CEMs, dating back to the beginning of the mission. The gain changes very slowly with time, so these effects are most significant later in the mission. The new calibrations will be incorporated in all future data.

2) Included velocities even at times when all other moments are unreliable. The speed moment is easiest to calculate, and so it is often valid even when other moments are not. The philosophy will be continued in all future data releases.

3) Reprocessed data during most solar particle events to account for the high background levels. Although the tracking of the solar wind beam by the instrument can get confused during such times, data are recoverable from many such intervals, and the required reprocessing has been done for these times.

12-13-2002 Release of new version of the SWEPAM Level 2 data
for Bartels rotations 2295 and 2297 (09/07/2001 through 10/03/2001
and 10/31/2001 through 11/26/2001)
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The SWEPAM team has released a new version of the SWEPAM Level 2 data for Bartels rotations 2295 and 2297. This change adds some data points during the high background intervals on days 267-270, 309-310, and 327-328 in 2001 (Sept 24-27, 2001, Nov 5-6, 2001, and Nov 23-24, 2001). All of the data points in the previous version remain the same, they have just reprocessed and recovered some additional data for this time period. The SWEPAM team has also produced a data file filling in the remaining gaps on days 268-269, 310-311, and 328 in 2001. These are not level 2 quality data, but the data are available on request from the team (Ruth Skoug, rskoug@lanl.gov).

Changes for SWEPAM Team software version 2.01, June 2002:
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Data have been reprocessed for Bartels rotations 2279-2295. This reprocessing was done to account for changing CEM gains by incorporating the results of the weekly on-board calibrations. No gain changes were observed prior to mid-2000, and the gain changes vary slowly with time. Thus changes due to this procedure are generally small, although they become more significant at later times. By rotation 2295, typical changes in density (from the previously released Level 2 values) are ~10%, changes in temperature are ~5%, and changes in speed are less than 0.5%. Note also that all future Level 2 data will include these improved calibrations.

Changes for SWEPAM Team software version 2.01, September 2000:
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1. Alpha/proton density ratios are now included in the files.

2. The aberation due to the motion of the Earth and the spacecraft is now included in both the scalar solar wind speed and in the solar wind velocity components.

3. We have improved our calculation of the instrument geometry factors, and this release uses our most recent, best values for the geometry factors.

While this change has a small effect on most data points, it is only significant at low solar wind speeds (<400 km/s), and allows us to extend the range of valid data down to speeds of approximately 320 km/s.

4) More bad data points have been removed.

5. The fill value for missing data has been changed from -999.9 to -9999.9

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INTRODUCTION
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This directory contains Level 2 hand-checked moments for the SWEPAM instruments on the Advanced Composition Explorer spacecraft.

SWEPAM consists of two independent instruments, one ion and one electron monitor. Combining their data sets is a PITA, so we have two separate types of files:

* ion moments files are of the form "swepam-swi-level2-XXXX.hdf", where "XXXX" is the Bartels cycle number for the collection. The extension indicates that the files are in NCSA's Hierarchical Data Format. See <URL:http://hdf.ncsa.uiuc.edu/> for information on reading HDF files.

  The file "swepam_dswi_level2.h" contains a C data structure suitable for feeding to ASC's wonderful "hdfgen.pl" script. hdfgen.pl will generate lovely C code to read in these HDF files and populate values in a usable C struct. See <URL:http://www.srl.caltech.edu/ACE/ASC/exhdfgen/index.htm> for details on hdfgen.pl.

* electron moments files are in ASCII format.

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Caveats and Warnings
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During periods of extremely high solar activity, such as the Bastille Day event (July 14 2000) the SWEPAM instrument is affected by energetic particles that penetrate the spacecraft and instrument and make spurious counts in the CEM detectors. Here is some detail about this issue, from Ruth Skoug of the SWEPAM team.

> The effect of the high background counts is to cause a breakdown in
> the SWEPAM algorithm which chooses the energy range to measure.
> At times with very high background counts, the instrument always
> measures the lowest possible energy range (~250 eV to 1.8 keV).
> If the solar wind speed is sufficiently high, this energy range
> does not include the main solar wind proton beam, and SWEPAM thus
> does not measure the bulk of the solar wind particles. This condition
> was true during the Bastille Day, 2000 storm, where the peak was
> seen at energies ranging from 2 to >5 keV. The instrument is still
> happy and healthy at these times, it just looks at the wrong energies,
> and so we are unable to get solar wind moments from these data.

However, the SWEPAM instrument has another mode which measures the full energy range (250 eV to ~17 keV) once each half hour. These data do show the solar wind peak, and the SWEPAM team has been able to extract

moments from these data. Currently, you need to contact the team directly to obtain these data:
Ruth Skoug - rskoug@lanl.gov

There are a few other periods of high solar activity during which the SWEPAM instrument has exhibited the same behavior.

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BARTELS CYCLES
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Bartels cycles are a wholly arbitrary unit of time corresponding to twenty-seven day "solar rotations". Each Bartels cycle starts at 00:00 UT and runs for exactly 27 days. Therefore, you can expect each file to contain 27 days worth of data.

Do not confuse with Carrington rotations, which correspond to actual solar rotations (0 to 0 degrees heliographic longitude at solar equator) as seen from Earth.

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PROCESSING REVISION
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Occasionally, the SWEPAM team makes improvements to the moments processing software. This results in better data.

Although the software revision is always indicated as an annotation inside the HDF file, it is not part of the filename and hence invisible to the casual observer.